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DYSFUNCTIONS OF THE PATENT SYSTEM AND THEIR EFFECTS ON COMPETITION¹

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I Introduction

The objective of this article is to analyze some current conflicts between patents and competition. Analyzing the tensions between these two instruments have been the subject of a large body of the economic literature and, after a long academic debate, patents and market competition are now considered by most economists as offering complementary rather than substitutable incentives in favour of innovation.⁴ Two statements summarize the current economic beliefs concerning the relationships between patents and competition: on the one hand, firms innovate to escape from competition (Darwinian view); on the other hand, the social benefits of innovation cannot be captured without the spur of competition and the scrutiny of antitrust law (mainstream view). However, despite this favorable convergence, some important tensions persist between the Intellectual Property and the antitrust authorities. One of the main arguments developed in this chapter is that these tensions mainly occur because the current patent system presents some dysfunctions that create distortions difficult to solve under the antitrust rulings. Besides the traditional conflict between the dynamic efficiency and the static deadweight loss, the contemporary dysfunctions of the patent system can be made easier to understand by recalling how the economic representation of patents has evolved.

In its initial and most common representation, a patent protects a *discrete* innovation, in other words an *isolated* innovation specific to a technology, without links to any downward or upward technology. It confers on its holder the temporary power to stop a third party from using the protected information that is disclosed in the patent without the holder's consent. A large proportion of the initial literature on patents uses the discrete innovation framework and reaches the unsurprising conclusion that a stronger patent protection promotes innovation. To obtain this result, the literature implicitly makes a number of assumptions.⁵ In particular, it assumes that a patent is an intellectual property asset satisfying the following properties: i) it confers a *perfect protection* to its holder: once granted it is presumed to be an unquestionable right. Moreover, it perfectly defines the *protected claims* that are disclosed in the patent. In other words, even though it is an intellectual property right, a patent is treated as any other *iron-clad* property right; ii) a patent is supposed to be the best instrument of protection because, unlike the trade secrecy, it allows the holder to collect *damages* when an infringement is detected; and iii) a patent delivers an autonomous and independent piece of information about knowledge, in the sense that the innovation it protects is not linked to other innovations, neither upstream nor downstream. In other words, there is a clear and unique connection between a technology and a patent. All these implicit assumptions were instrumental in the development of a huge economic literature, focused on one hand on the socially optimal design of the patent in terms of *duration and scope of protection*, and on the other hand on

¹ We thank Simon Lapointe for a careful reading of a previous version and useful suggestions.

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⁴ The question whether patents and competition are complementary or substitutable instruments of the innovation process has been debated for a long time. Since the first Schumpeterian analyses and the more recent works of Bessen and Maskin (2009), Boldrin and Levine (2008), various economists (see Aghion *et al.* (2001), Aghion and Griffith (2005), Encaoua and Ulph (2004)) have shown that in a dynamic rivalry framework with a step by step process innovation, the two instruments are rather complementary as long as the intensity of competition in the product market is not too high. Moreover, the contemporary evolution of competition policy towards intellectual property is largely favourable to the complementary perspective.

⁵ For an overview, see Encaoua *et al.* (2006) and Harhoff *et al.* (2007)

the links between *innovation* and *competition* (Gilbert 2006). The progressive challenge to these different assumptions contributed to the analysis of new concerns raised by the development of the patent system.

The challenge to the first assumption led to a careful (re)examination of the consequences of a rather *uncertain protection* by the patent. The uncertainty has been exacerbated in recent years by abusive award of patents to applications that do not fully satisfy the patentability criteria, notably that of the required *inventiveness* (or *non-obviousness* in the American language). Awarding patent rights to *dubious* applications is thus the first dysfunction of the patent system. It considerably affects competition in the product market. Patents that are dubious or too broad (i.e. incorporating claims with an excessive scope) harm the equilibrium between intellectual property and competition by discouraging the monitoring of innovation and by artificially increasing final prices due to unwarranted royalties. In its 2003 report⁶, the Federal Trade Commission concluded that increasing the quality of awarded patents should be a top priority to re-establish the equilibrium between intellectual property and competition. When uncertain patents covering valuable products exist, it is no longer true that a stronger protection promotes innovation. Moreover, an uncertain protection undermines the intrinsic superiority of the patent over other forms of protection, suggesting that if the number of patent applications is maintained at a very high level, it is because a patent has a different function than simply insuring protection against imitation.

A second characteristic of the patent system is the fact that patents are increasingly used as instruments in *technology exchanges*. It is illustrated by the importance of the *open innovation organization* and the frequent use of *patent trading* between various agents.⁷ Assumption iii/ in the traditional representation of the patent is now replaced by a cumulative conception of the innovation process. The view that technological change is not an isolated event but a *sequential process* in which each innovation is built on knowledge patented by forerunners has two consequences. First, the patent's function is not only to protect the holder from a malicious imitator (backward protection), but also to block a follow-up innovation (forward protection). Second, while the discrete view emphasized competition in the product markets, the cumulative view focuses on *competition on the markets of technological exchanges*. Technological competition in these markets may be affected by *hold-up* behaviour. For example, a patent holder can accuse a producer of patent infringement, by pretending that the patent covers some of the technologies that he is using for his production. This accusation can be especially detrimental to the producer when it is made *ex post*, i.e. after the second innovator completed the investment necessary for his activity. A further escalation is reached when the patent holder sues for infringement not on a delivered patent, but on a *patent pending* not yet published. Indeed, the laws on *divisional* patent applications or on *continuation* patent applications authorize an initial depositor to act as if the date of the new application ran from the date of the initial application. In some situations, the potential infringer could have acted while ignoring the existence of a *divisional patent* application, which would explain why he did not request an authorized license from the holder before starting production of its own good. Finally, when a license royalty is required *ex post* by the patent holder, its level can be excessive compared to the level that would have been required if the negotiation had happened *ex ante* (i.e. before the producer started production of its good). The *hold-up* situation is made worse when the patent holder requests that the potential infringer stops his activity by obtaining a *relief injunction*. The *threat of injunction* that weighs on the downstream innovator clearly gives an advantage to the upstream innovator. Are such threats legal from the point of view of intellectual property law? Some believe so, arguing that an injunction is the normal consequence of the

⁶ FTC, "To Promote Innovation: The Proper Balance of Competition and Patent Law and Policy", 2003

⁷ The contemporary specificities of the modes of organisation and coordination of research put the emphasis on *open innovation systems*, in which knowledge exchange between multiple agents take priority over independent and individual research.

protection awarded to a patent holder. Others believe that injunctions should not be authorized, arguing that these practices constitute serious obstacles to the continuous operation of markets.⁸

Finally, a third and more contemporary dimension of the patent system further complicates the question of the tensions between patents and competition. In the cumulative conception of innovation, some patents act not only in a *sequential* manner as assumed in the previous paragraph, but also in *clusters*: it is the case when the use of numerous independent patents is necessary to produce a single good.⁹ Not only does this clustering increase the transaction costs due to the so-called *patent thicket*, but it may also create an obstacle to further innovation. It is now the fight *for* the market, and not *on* the market, that matters. Patent races are essential instruments in this competition. In opposition to the free entry assumptions used in most of the endogenous growth models, patent races are governed by *imperfect competition*. The accumulated patents strongly influence the structure of the races, thus having an effect on the competitive mechanisms on the *innovation markets*. The massive sales of patent portfolios that are observed illustrate the important role of these intellectual property instruments for the conquest of new markets. Two factors contribute to the appearance of this phenomenon: the conjunction of a high *fragmentation* of intellectual property rights, and the development of a great number of *complex technologies* that require many patented elementary components. Many sectors of the ICT industries (Information and Communication Technology) produce goods that require the use of a great number of patented components. Even if each component represents only a minor part of the value of the final good, it still may be an *essential* input. In part because the coordinated price of a collective license can be inferior to the sum of the prices of the independent licences, economic efficiency requires that *complementary patents* be coordinated through a *patent pool* or through a Standard Setting Organization (SSO) tasked with the choice of a *technological standard*. However, as in any process in which complementarities between independent inputs require a coordinated behaviour, individual deviations from the collectively defined norms are frequent. For example, it may happen that during an SSO's deliberation, an agent certifies that he has no intellectual property relevant to the standard. Thus, the chosen standard may be based on this certification. But after the standard adoption, the same agent allegedly demands royalties from those using its technology in connection with that standard. This type of deviation, illustrating once again *hold-up* behaviour, can have significant impacts in terms of competition, especially in the *innovation market*. The coordination process can also cause other different problems. For example, the determination of the *essential* patents can lead to conflicts when substitutable technologies are in presence. Moreover, agreeing on the economic principles that a *collective license price* must satisfy is not an easy task. Finally, the risk of *collusive behaviour* is never absent. Indeed, it is difficult for antitrust authorities to mitigate this risk.

The paper is organized around the three aforementioned dysfunctional aspects that affect the competition process respectively in the product markets, the technology markets and the innovation markets: the issue of bad quality patents (II), the hold-up behaviour in follow-up innovation (III), and the coordination issue in patent pools and technological standards (IV).

II. Patents Quality and Competition in the Product Markets

⁸ A question that appears essential is whether competition authorities have the appropriate legal instruments to convict abusing patent holders. For example, it is possible that some behaviour can be considered *abusive* while its author is not in a *dominant position*, which makes the application of antitrust laws difficult at least in Europe.

⁹ Scotchmer (2004) uses the term *research tools* to designate the set of patented inputs that are involved in the production of a second-generation good. For example, the cultivation of genetically modified seeds simultaneously requires the use of different genes, each with its specific properties. It also requires potentially patented techniques to insert these genes in the *germplasm* (the element issued from the source vegetal that can give a new individual).

It is commonly recognized that the number of patent applications is very large and increasing, as illustrated by the following figure for the United States: *“Every Tuesday, the day of the week the US Patent and Trademark Office (USPTO) issues new patents, there are roughly 3,500 new patents, corresponding to new IP rights that no American is allowed to infringe, and for which there is no fair use defence to patent infringement like with copyright and trademark”* (Lei and Wright, 2010). This figure reflects the sign of a very dynamic and innovative economy as the U.S. but one cannot disregard the possibility that many of these patents may be of *bad quality*, in the sense that they fail to satisfy at least one of the patentability criteria: *utility*, *novelty*, and *non-obviousness (inventivity)*. The US Patent and Trademark Office (USPTO), and to a lesser extent the European Patent Office (EPO), are trapped in an uncomfortable position defined as follows by Lemley (2012): *“The Patent and Trademark Office finds itself caught in a vise. On the one hand, it has been issuing a large number of dubious patents over the past twenty years, particularly in the software and electronic commerce space. It issues many more patents than its counterparts in Europe and Japan¹⁰; roughly three-fourths of applicants ultimately get one or more patents, a higher percentage than in other countries. Complaints about those bad patents are legion, and indeed when they make it to litigation they are quite often held invalid. Even the ones that turn out to be valid are often impossible to understand; in the information technology industries, there is no lawsuit filed in which the parties don’t fight over the meaning of patent claim terms.”¹¹*

It is now largely admitted that a patent is not an ironclad right as are other forms of property. A patent is more likely an *uncertain* or a *probabilistic right* (Ayres and Klemperer (1999), Shapiro (2003), Lemley and Shapiro (2005)). The two most important points are that some of the dubious patents are of large economic significance and the enforcement uncertainty is largely strengthened by the issuance of too many bad quality patents.

Three questions emerge: 1/ why are so many bad quality patents granted by a patent office? 2/ how does the uncertainty on the patents’ quality affect the choice of a protection regime? 3/ to what extent do the patent holder and potential infringers prefer to settle their private disputes on the patent's validity rather than pursue their litigation in front of a court, and what are the consequences of these private settlements on market competition?

II.1 Two Views the Reasons for the Issuance of Bad Quality Patents

Besides the anecdotal evidence on some exotic patents,¹² we know that a large number of economically valuable products are protected by *weak patents*, i.e. patents that would likely be invalidated by a court if they were the subjects of litigation. Examples include drugs such as Lipitor, genetic material such as the stem cells of the Wisconsin Alumni Research Foundation (WARF), the Breast Cancer Genes BRCA1 and BRCA2 (Myriad Genetics), software such as the File Allocation Table (FAT) by Microsoft, etc.¹³

Why are so many bad quality patents granted by the USPTO? To answer this question, Lei and Wright (2010) contrast two possible explanations. The first relies on the *“rational ignorance”* principle advanced by Lemley (2001), according to which the USPTO examiners *voluntarily* conduct *insufficient prior art search* that could render weak patents unpatentable. Lemley argues that by so doing, US examiners *“are ‘rationally ignorant’ of the objective validity of patents... because it is too costly for*

¹⁰ Van Pottelsberghe de la Potterie (2010).

¹¹ Bessen and Meurer (2008)

¹² Examples include crustless peanut butter, jelly sandwich, swinging on the swing, etc. See Jaffe and Lerner (2004).

¹³ See the web site www.pubpat.org of The Public Patent Foundation (PUBPAT). This foundation represents the interests of the public in the patent system. Even if the foundation shares the view that a properly functioning patent system can help an innovative economy, it takes a great care to avoid the negative effects that *over-patenting*, *unmerited patenting* and *excessive patent rights* can have on society. Its aim is to protect freedom from illegitimate constraints.

them to discover those facts.” Given the skewed nature of the patent value distribution, “society would be better off economizing on examinations, deferring rigorous determination of validity until the patent enters litigation.” The second explanation denies the examiner’s ignorance and focuses on the existence of an “institutional pro-applicant bias” in the USPTO. “There exists a pro-applicant bias of policies and procedures at the USPTO that renders patent examiners’ effort useless: they are encouraged by various institutional incentives to accept applications that they nevertheless perceive to be ineligible” (Jaffe and Lerner, 2004). There are at least three institutional biases that force the USPTO examiners to grant undeserved patents: i/burden of proof; ii/ incentives; iii/ continuation and divisional patents.

i/ *Burden of proof.* In the US as in Europe, an applicant does not have to prove that the application is patentable. It is the examiner's burden to prove that the application is unpatentable, which is generally a very time consuming task. The *opposition procedure* in Europe allows a third party to make an opposition. This procedure is adversarial between the challenger and the patent holder. By contrast, in the United States, the *re-examination procedure* does not involve any adversarial procedure since it maintains an exclusive relationship between the applicant and the patent examiner (Graham *et al.* 2004, Harhoff and Reitzig, 2004).

ii/ *Incentives.* US patent examiners are mainly rewarded on granted patents, and do not bear the aftermath of granting questionable patents. “The salaries of US examiners are tied to the number of applications they process: they have production quotas to meet, and earn bonuses when they exceed their quotas by at least 10%...Importantly, they are never liable in the event patents are invalidated in court and there are no negative consequences for examiners who produce low-quality work” (Langinier & Marcoule, 2009). In Europe, the rewards of EPO examiners are equivalent to those at USPTO, but the tie between salary and productivity is somewhat less stringent. This difference is illustrated by a lower workload for European examiners than for American ones: the number of filings per examiner is 37 at the EPO and 97 at the USPTO, and the pendency allowed for both the prior art search and the examination process is 50 months at the EPO vs. 27 months at the USPTO. These figures may explain why the EPO grants fewer dubious patents than the USPTO, and illustrate the importance of the quantity-quality trade-off in the patent system (Guellec and van Pottelsberghe, 2007, ch.7).

iii/ *Continuation and divisional patents.* Continuation and divisional patents are common practices. “A continuation is a second application for the same invention claimed in a prior nonprovisional application and filed before the original prior application becomes abandoned or patented. A divisional application or division is a later application for an independent or distinct invention, carved out of a pending application and claiming only subject matter disclosed in the earlier or parent application. Continuations are not permitted by the EPO and the JPO but are allowed by the USPTO. Divisional patents are permitted by the EPO, and provide a kind of alternative to continuations.” (Hedge *et al.*, 2007). Such applications offer means to tune a patent’s claims to changing circumstances. According to Lemley (2012), in the US, the use of continuations is largely applicant-rather than examiner driven. Moreover, the ability of applicants to file an unlimited number of continuation applications – and their willingness to do so – makes it difficult for examiners to simply reject bad applications. “Applicants view a rejection as simply a negotiating position that invites a counteroffer, not as a judgment that their application is in fact unpatentable. And because they can continue making counteroffers, increasing the number of rejections simply prolongs the application process” (Lemley, 2012).

In order to test whether the rational ignorance principle or the institutional bias best explains the issuance of bad quality patents in the US, Lei and Wright (2010) construct a sample of *twin patents*, i.e. patents that are filed to both the USPTO and the EPO during the period 1990 - 1995 and are granted by the USPTO while resulting at the EPO in one of the three possible outcomes: granted, rejected or withdrawn by the applicant. They assume that the European Patent Office (EPO) grants fewer dubious patents than the USPTO and they test whether the *rate of failure at the EPO* is linked to the *prior art research effort* made by US examiners. The outcome of a patent prosecution at the EPO is used as an indicator of the patents' strength: an application for a *weak patent* would have a

high probability to be either withdrawn by the applicant or rejected by the EPO. In order to measure the prior art research effort made by USPTO examiners, the authors define the *Prior Patents Search Intensity* (PPSI) by the ratio $PPSI = CPP/(CPP+UPP)$, where the variable CPP is the number of *Cited Prior Patents*, and the variable UPP is the number of *Uncited Prior Patents*, both evaluated for each patent. While the number of *Cited Prior Patents* (CPP) appears directly in the application, the number of *Uncited Prior Patents* (UPP) was computed by the authors by using a specific algorithm (Latent Semantic Analysis). The higher the value of the PPSI ratio, the higher is the research effort devoted by the examiners to find the appropriate *prior art*. The purpose is to test which one of the two following alternative hypotheses H_1 and H_2 best explains the issuance of *weak patents* by the USPTO, i.e. patents that are withdrawn or rejected by examiners at the EPO:

H_1 : *Rational ignorance*: a USPTO patent with a high amount of cited prior art (i.e. a patent having a high PPSI) signals a *strong patent* that would have a high probability to be accepted by the EPO.

H_2 : *Institutional bias*: a USPTO patent with a high amount of cited prior art (i.e. a patent having a high PPSI) signals a *weak patent* that would have a high probability to be rejected by the EPO or withdrawn by the applicant while it is granted by the USPTO.

The main econometric result of Lei and Wright is in favor of H_2 : the probability of failure at the EPO is significantly and positively affected by the PPSI ratio, measuring the research intensity of the prior art at the USPTO. This result suggests that US examiners devote important *prior research intensity* to patents that they perceive as being weak, but despite their negative perception, the rules and procedures of the USPTO force them to grant a patent to these weak applications. In other words, even though US examiners ultimately fail to reject weak patents, their revealed evaluation measured by the PPSI ratio is a significant predictor of the application outcome at the EPO.

Lemley (2012) suggests two ways to improve, at least partially, the quality of granted patents: a *tiered review process* and a *post-grant opposition procedure*: “To harness information in the hands of patent applicants, we could give applicants the option of earning a presumption of validity by paying for a thorough examination of their inventions. Put differently, applicants should be allowed to “gold plate” their patents by paying for the kind of searching review that would merit a strong presumption of validity. An applicant who chooses not to pay could still get a patent. That patent, however, would be subject to serious—maybe even *de novo*—review in the event of litigation”... “Post-grant opposition is a process by which parties other than the applicant have the opportunity to request and fund a thorough examination of a recently issued patent. A patent that survives collateral attack should earn a presumption of validity similar to the one available through tiered review. The core difference is that the post-grant opposition is triggered by competitors—presumably competitors looking to invalidate a patent that threatens their industry. Like tiered review, post-grant opposition is attractive because it harnesses private information; this time, information in the hands of competitors. It thus helps the PTO to identify patents that warrant serious review, and it also makes that review less expensive by creating a mechanism by which competitors can share critical information directly with the PTO. A post-grant opposition system is part of the new America Invents Act, but it won’t begin to apply for another several years¹⁴, and the new system will be unavailable to many competitors because of the short time limits for filing an opposition”.

II.2 Choice of the Protection Regime: “Big Secrets” and “Little Patents”

A first consequence of the uncertainty attached to a patent is related to the choice made by an inventor to protect his innovation. Empirical studies from inventors’ surveys (Cohen *et al.* 2000, Levin *et al.* 1987, Arundel and Kabla 1998) revealed that in many industrial sectors, the resort to patents was not the preferred form of protection of innovators. What drives the individual choice between patent or other forms of protection?¹⁵ Some theoretical studies tried to answer this question by

¹⁴ Post-grant opposition is available only for patents granted on applications filed after April 16, 2013. Because the average time to grant is close to four years, it will likely be the latter part of this decade before many patents are eligible for post-grant opposition.

¹⁵ See on this question the recent survey by Hall, Helmers and Sena (2012).

taking into account the *strength of a patent*, evaluated as the probability that a court confirms both the patent's validity and the infringement. For a strong patent, the probability is close to one, while for a weak patent, it is close to zero. Consider a process innovation that allows the reduction of production costs. The approach developed by Anton and Yao (2004) involves the *asymmetry of information* between the inventor and third parties: the inventor knows precisely the amount of the cost reduction allowed by the innovation, but third parties, including potential competitors, have only partial information. The information that reaches them depends on what the innovator chooses to disclose when patenting its innovation. The cost reduction level disclosed in the patent thus becomes a strategic choice for the patent applicant.¹⁶ However, the imitator can also obtain additional information by himself if he chooses to *reverse engineer* the innovation. Anton and Yao (2004) show that choosing the patent protection leads to two opposite effects. On one hand, there is an *imitation effect*: a weaker patent will contain less information, because the potential imitator has lower chances of being convicted and fined by a court when the patent is weak. Therefore, since it is in the interest of the imitator to copy everything disclosed in the patent by the holder, a weak patent holder's interest is to disclose as little as possible. On the other hand, there is a *signal effect*: a strong patent encourages a high level of disclosure. Indeed, because a strong patent is unlikely to be imitated, it is not risky for a strong patent holder to disclose the effective cost reduction, thus signalling his technological advance to competitors. Obviously, this reasoning would not hold with a weak patent. Overall, the level of disclosed information allows an arbitrage between the two effects described above. Using a signalling game framework, Anton and Yao (2004) show that in equilibrium, only those process innovations with a cost reduction inferior to a certain threshold stand to gain from being patented, while innovations with value superior to this threshold benefit more from being kept secret. The main result of this model, in which patent protection is *probabilistic*, is that the arbitrage between patent and secret leads to the patenting issue solely for low-value innovations (the so called "little patents") which have a small chance of being imitated. In contrast, high-value innovations are better protected by secret ("big secrets"). Note that in the model of Anton and Yao (2004), the decision to imitate or not results from the amount of information the innovator chooses to disclose, and not from the independent imitator's choice.

An alternative approach is developed in Encaoua and Lefouili (2005). In that model, the decision to imitate or not is assumed to depend directly on the imitator's behaviour and not on the innovator's choice. The emphasis is put on three factors: i) the *strength of the patent* as previously defined; ii) the *relative cost of imitation*, whether the innovation is patented or kept secret, the cost of imitation being lower for a patent due to the compulsory disclosure; iii) the *size of the innovation* defined as the cost reduction allowed by the process innovation. Furthermore, the *level of imitation* is an endogenous variable chosen by the potential imitator. Then, the interactions between these different factors lead to novel situations. For example, the choice of patenting the innovation leads to a level of imitation that can differ from the level that would have arisen if the innovation had been kept secret. Moreover, the innovator can be better off when imitated if the loss he suffers on the market from being imitated is more than compensated by the expected value of collected damages. Two effects are thus identified.¹⁷ The first, called the *damages effect*, says that with identical levels of imitation, the innovator will always prefer a patent to trade secret, because the imitation of a patent

¹⁶ It is important to note that even if under the patent law an applicant is required to disclose sufficient information to enable someone skilled in the art to make and use the claimed embodiments of the innovation, what the applicant really discloses remains discretionary. It may be only a part of the technically relevant information, since it is only what the patent holder discloses in the patent that enables a competitor to imitate.

¹⁷ The two effects that determine the choice of the protection method are highlighted in the following decomposition. Let $\Pi_{1P}(d_1, d_2, \theta)$ denote the profits induced by a patented innovation when the innovator reduces costs by d_1 , the imitator reduces its costs by d_2 and the strength of the patent is θ . Also let $\Pi_{1S}(d_1, d'_2)$ be the profit induced by an innovation kept secret when the innovator reduces costs by d_1 , the imitator reduces its costs by d'_2 . The difference in profits for the innovator in the two cases can be written as: $\Pi_{1P}(d_1, d_2, \theta) - \Pi_{1S}(d_1, d'_2) = (\Pi_{1P}(d_1, d_2, \theta) - \Pi_{1S}(d_1, d_2)) + (\Pi_{1S}(d_1, d_2) - \Pi_{1S}(d_1, d'_2))$. The first term of the decomposition,

leads to compensation in the form of damages. The second effect, called the *competition effect*, makes more explicit the influence of the imitation level on the innovator's profit. As stated above, this level of imitation can differ according to the protection mode. If the imitation level is lower for a patented innovation than for a secret innovation, the competition effect reinforces the damages effect: the innovator will prefer a patent. However, if the imitation level is higher for a patented innovation than for a secret innovation, the two effects go in opposite directions. The composition of the two effects necessitates in this case a deeper analysis. Adopting the expression of damages that result from the *unjust enrichment doctrine*, Encaoua and Lefouili (2005) reach the following conclusion: in the perfect equilibrium of the 3-stage game, where the protective choice is made at the first stage, the decision to imitate and the choice of the imitation level are made at the second stage, and Cournot competition on the product market occurs in the third stage, there exists a threshold such that the innovations involving a *cost reduction below the threshold are always patented*, while those with a *cost reduction above the threshold are better protected by secret*. The result is consistent with the one obtained by Anton and Yao (2004) albeit in a different framework. It finally challenges the justification for the patent as a universal protection instrument for innovation.¹⁸

II.3 Private Settlements

Challenging a patent's validity through litigation is costly and uneasy for at least three reasons. First, the patent holder may contractually prevent litigating.¹⁹ Second, the required *clear and convincing evidence* standard in the US to prove invalidity is in general very demanding for the challenger, especially for new patentable subject matters like software.²⁰ Third, challenging has the dimension of a *public good*: a firm benefits from a successful challenge initiated by another competitor, since it gets the new technology freely. Therefore, the individual incentives to challenge a patent's validity are low. This is why disputes on weak patents are more frequently solved through *private settlements* than through a judicial litigation procedure. But not only are patents for which litigation go to completion in front of a US Court invalidated in a high proportion (about 50% according to Allison and Lemley, 1998), they also include patents of great commercial value.²¹ For these three reasons, private settlements are often preferred to legal proceedings. But, even if public policy encourages private settlements of legal disputes, it does not follow that all settlements are consistent with the public interest. Gilbert (2006) makes the following distinction: "*If the patent is valid and would be infringed, the patent gives its owner the right to exclude a rival that employs the teaching of the patent, and a settlement that allows the alleged infringer to stay in the market would not be anticompetitive. On the other hand, if the patent is not valid or would not be infringed, a settlement between a patentee and a potential entrant that limits the ability of the entrant to compete against the patentee could harm competition that would have occurred in the absence of the settlement.*"

which is always positive, corresponds to the damages effect. The second term corresponds to the competition effect. It can be positive (if $d'_2 > d_2$) or negative (if $d'_2 < d_2$).

¹⁸ Note that both the models of Anton and Yao (2004) and Encaoua and Lefouili (2005) focus on process innovations. We are not aware of an existing analysis of the choice between patent and secret for product innovations.

¹⁹ For instance, in Japan, Microsoft forced its licensed OEM suppliers to pledge not to file lawsuits on the grounds that Windows infringes a patent right.

²⁰ This is illustrated by the recent *i4i vs Microsoft* case. See Supreme Court of the United States, *Microsoft Corp. v. I4I Limited Partnership et al.* Certiorari to the US Court of Appeal for the Federal Circuit, 9 June 2011.

²¹ To illustrate this last point, Chiron's patent on monoclonal antibodies specific to breast cancer antigens was invalidated in 2002 in a suit in which Chiron had sought over \$1 billion in damages from Genentech. Another example relates to the Prozac drug. The U.S. Court of Appeals for the Federal Circuit invalidated an Eli Lilly patent on Prozac in 2000 and caused Lilly's stock price to drop 31% in a day.

We discuss briefly two types of private settlements that affect negatively the competition in the product market: the so-called “reverse payments” practice observed in the pharmaceutical industry and the specific “per-unit royalty licensing scheme” that occurs under the shadow of patent litigation.

i/ *Reverse payments in the pharmaceutical industry.* Some branded pharmaceutical companies pay a large amount of money to a generic producer to delay its entry in their market. This practice harms the society since it delays access to a less expensive generic drug. However, it is not obvious whether this practice violates antitrust rules.²² On the two sides of the Atlantic, the antitrust enforcers believe that *reverse payments* are anticompetitive since they improperly raise consumer costs by keeping out less expensive generic drugs. But some differences appear between the US and the EU. In the US, the Federal Trade Commission (FTC) and the Courts have radically opposed views on this practice. While the FTC considers such settlements as unlawful regardless of who ultimately would have won the patent litigation, the US courts reject this reasoning, requiring those challenging such reverse payments to show that the settlement impacts competition for products not covered by the patents, or that the underlying patent infringement is objectively baseless or based on fraud. In Europe, both the Directorate-General for Competition and the Court of First Instance (CFI) seem to agree in condemning private settlements that involve a reverse payment, whether the patent is valid or not (as illustrated by the recent *Boehringer Ingelheim vs Almirall*). Moreover, commentators differ markedly in their views of reverse payment settlements. Some of them believe that, in the US, *reverse payments* are a consequence of the facilitation of generic entry procedure derived from the Hatch-Waxman Act.²³ Others consider that the *reverse payment* cases constitute an “important category of cases in which the terms of the settlement themselves tend to indicate that the patent was weak and thus that competition was diminished by the settlement” (Shapiro, 2003).

ii/ *Licensing a weak patent under the shadow of patent litigation.* Consider the situation where the holder of a patented process innovation is confronted to a set of oligopolistic firms that are potential users of the cost-reducing innovation. Suppose that the patent covering this innovation is *weak*. Licensing it under the shadow of patent litigation implies that the patent holder prefers to license its patent at a price that deters any challenge rather than the option to pursue an infringer in a Court, since in a trial the infringer will likely try to challenge the patent’s validity. Therefore the licensing price is such that any potential licensee will prefer to accept the license rather than to litigate the patent’s validity. In other words, licensing a weak patent under the shadow of patent litigation

²² The assessment of this practice by the US Supreme Court is illustrated by this quotation extracted from “Brief for the US as Amicus Curiae in Federal Trade Commission, Petitioner v. Schering-Plough Corporation, et al.” (US Supreme Court 05-273): “*Patent litigation settlements that include reverse payments thus implicate conflicting policy considerations and complex legal issues at the intersection of patent and antitrust law, with further complexity introduced in the pharmaceutical context by the dynamics of the Hatch-Waxman Act. On the one hand, the interests in consumer welfare protected by the antitrust laws militate against adoption of a legal standard that would facilitate patent holders’ efforts to preserve weak patents by dividing their monopoly profits with settling challengers. The risks are magnified when the settling parties are in a position to utilize the Hatch-Waxman exclusivity period to further constrain competition from other generic manufacturers. On the other hand, the public policy favoring settlements, and the statutory right of patentees to exclude competition within the scope of their patents, would potentially be frustrated by a rule of law that subjected patent settlements involving reverse payments to automatic or near-automatic invalidation*”.

²³ One of the peculiarities introduced by the Hatch-Waxman Act (1984) is to allow a generic drug to avoid the usual tests (known as the NDA, New Drug Application) required by the Federal Drug Agency to obtain the market’s entry approval. For a generic, the Hatch-Waxman Act requires a less demanding test (known as the ANDA, Abbreviated New Drug Application). An ANDA requires only demonstrating that the proposed generic drug is bioequivalent to an approved pioneer drug. Providing evidence of safety and effectiveness from clinical data or from the scientific literature is not necessary. To compensate such easier entry by generics, the Hatch-Waxman Act extended the patent length of the brand name drug by restoring the time period lost while awaiting NDA approval. The maximum extension period is capped at a five-year period, or a total effective patent term after the extension of not more than 14 years (see, Thomas, 2006; Appelt, 2010).

implies a licensing scheme that deters any litigation.²⁴ A recent paper by Amir *et al.* (2011) investigates the nature of the best licensing scheme when the patent is weak and asks whether the result is robust against features that matter when the patent is certain. The main result in Amir *et al.* is that a weak patent holder prefers a per-unit royalty to a fixed fee when the positive price effect outweighs the negative quantity effect of a cost increase. The authors show that this condition is satisfied regardless of whether: i/ the licensor is an outsider or an insider in the downward oligopoly market, ii/ the licensees compete à la Cournot or à la Bertrand and, iii/ the downward market includes homogeneous or differentiated products. Thus, contrary to what happens for an ironclad right, *the owner of a weak patent always prefers a per-unit royalty to a fixed fee.*²⁵ Licensing a weak patent with per-unit royalty allows the patent holder to extract more revenues than with a fixed fee, because the licensee can pass the corresponding unit cost increase to the consumers, explaining why licensees also prefer a per unit royalty. The only agents that suffer are the consumers of the final product: they pay a higher price than they would if the patent's assessment was made prior to licensing. Therefore licensing a weak patent under the shadow of patent litigation raises both a *private problem* and a *public problem*. The *private problem* arises because individual potential licensees have insufficient incentives to challenge the patent's validity alone: this is a direct consequence of the public good nature of challenging.²⁶ A *public policy* problem also arises because a weak patent holder is able to harm consumers by setting a per-unit royalty that increases the cost and therefore the price.

III. Sequential Innovations, Hold-up and Competition in Technological Markets.

We have so far examined the case of a *discrete innovation* and have analyzed the effects of the uncertainty relative to the patent's validity by showing how this uncertainty affects the competition on the product market. We now examine the effects of patents covering *follow-up* or *sequential innovations* in the sense that each innovation is built on previous patented knowledge. In such a framework, the delimitation of property rights between downstream and upstream innovators becomes crucial (Scotchmer, 2004). The uncertainty inherent to this delimitation is likely to result into a *hold-up*. For instance, a patent holder can unpredictably block the activities of an existing producer, accusing him of using the technology protected by the patent without the owner's consent.²⁷ The plaintiff can be either the patent owner himself or some other party acting on behalf of the presumed infringed party.²⁸ The plaintiff can obtain from a court an injunction ordering the

²⁴ A recent OECD Inquiry (Zuniga and Guellec, 2009) finds that avoiding patent litigation is an important motive of licensing.

²⁵ The intuition of this result may be summarized as follows. For a certainly valid patent, the patent holder cannot control the number of licensees when a per-unit royalty is used while he can with a fixed fee license. This advantage of fixed fee over per-unit royalty contracts is absent when the holder of a weak patent wants to make a license offer that deters litigation: indeed such offer has to be accepted by *all* firms. This suggests that a per-unit royalty scheme can be preferred over a fixed fee scheme if the patent is weak whereas the reverse holds if the patent is valid with certainty. Moreover, since licensing occurs *ex ante*, i.e. before an assessment of the patent's validity, the per-unit royalty licensing revenue is greater than the expected revenue obtained when licensing occurs after the patent's validity assessment, whereas a fixed fee licensing leads to the same revenue whether licensing is made *ex ante* or *ex post*.

²⁶ The Patent Reform Act (2011) recently adopted in the US tries to include different measures addressing the insufficient incentives to challenge a weak patent, by introducing for example some adversarial procedures to challenge a patent's validity as it exists in Europe.

²⁷ It is interesting to note that it is precisely in this sequential innovation framework that Bessen and Maskin (2009) could show that imitation was not socially reprehensible, thus reducing the necessity for patents.

²⁸ The third party acting on behalf of the patent's owner is called a *Non-Practicing Entity*, sometimes qualified as a *patent troll*.

definitive cessation of the activities of the presumed infringer.²⁹ Should the *threat of injunction* be considered as an abusive way for the patent holder to obtain *ex post* a substantial financial compensation in the settlement or does it correspond to the normal use of a right attached to the patent? The question is complex and does not receive a consensual answer. Some believe that a patent holder has the right to use the threat of injunction since it is a tool to deter a third party from using the patent unduly. Others believe the opposite, arguing that the threat of injunction corresponds to an opportunistic *hold-up* behavior since it occurs after the victim started its productive activities.³⁰ The following paragraph briefly presents some contributions justifying these different positions.

III.1 Injunctions, Hold-Up and Excessive Royalties: Shapiro's Model

The contribution by Shapiro (2010) analyzes the links between the level of royalties and the injunction power in a bargaining model in which the patented innovation of an upstream producer is an input for a downstream producer. By spending a specific cost, the downstream producer can get around the patented input and build a substitute. The model integrates the following elements: i) the patent protecting the upstream input is uncertain, which leads to the consideration of the patent's strength as a parameter of the model; ii) the value-added derived by the downstream producer from the upstream input is assumed to be observable; iii) if a court upholds the patent's validity and recognizes the infringement, an *injunction* to stop the downstream production is legally executable; iv) the amount of *reasonable royalties* that the patent holder could have obtained *ex ante* is known by both participants; and v) the final demand facing the downstream producer does not depend on the royalty paid for using the upstream input. *Ex ante*, the downstream producer may be either informed or uninformed of the existence of a patent covering the input. A central investigation of the model is to assess the *effect of the injunction on the royalty*. This is obtained by computing the gap between the *effective royalty* and the *reasonable royalty*, the *effective royalty* being defined as the Nash solution of a bargaining game, in which the outcomes of a preliminary injunction serve as the threat point. Without much surprise, one of the principal results of the Shapiro's model (2010) is that the gap is larger when the downstream producer decides to use the input *before* the uncertainty on the patent is resolved. This *patent ambush effect* highlights the fact that a patented input can penalize an uninformed user.³¹ A more surprising result is that the excessive part of the royalty is larger when: 1) the share of the upstream input in the value-added of the final product is smaller; 2) the injunction power of the patent holder is higher; 3) the protection of the upstream input results from a patent *pending*, in other words not yet published when the producer decides to incorporate the input in its product. These results led Shapiro to suggest restrictive conditions under which an injunction rule may be authorized. The *exceptional conditions* recommended by the Supreme Court in the *eBay v. MercExchange* case serve to define these restrictions: i) the prejudice suffered by the

²⁹ The best illustration is given by the Blackberry's story. In November 2001, the firm NTP, Inc. was filing a complaint with Virginia State Court of Justice, against the Canadian firm Research in Motion (RIM), producer of the Blackberry mobile phone, for the usage of technologies protected by old patents that are not yet expired, held by NTP. After long legal proceedings, including a re-examination of the aforementioned patents by the USPTO, the Court pronounced RIM guilty, and condemned the firm to pay damages and stop production of the Blackberry. The injunction decision remained pending during the appeal procedures brought by RIM with the Court of Appeals for the Federal Circuit (CAFC). After confirmation by the latter of the previous court's decision, RIM reached a private settlement in 2006, agreeing to pay \$612.5 million to NTP, obtaining that NTP would withdraw its complaint. The most significant aspect of this example is that after the settlement, NTP's patent has been invalidated by the Patent Office!

³⁰ The Supreme Court of the United States expressed in an ulterior affair (*eBay v. MercExchange*) some reserves against the justification of preliminary injunction and restricted the use of this practice to the so-called *exceptional circumstances*.

³¹ The ability of a patent holder to negotiate *ex post* a level of royalties that is superior to what would be reasonable *ex ante* is one of the advanced reasons to explain the rate of growth of the number of patent applications.

plaintiff is irreparable; ii) monetary damages are insufficient to compensate the prejudice; iii) given the prejudices of the plaintiff and the defendant, affecting the capital of the defendant is appropriate; iv) no component of society, other than the defendant, should be negatively affected by the injunction. Shapiro's model recommends the use by the plaintiff of a preliminary injunction only under these stringent conditions. In the following paragraph, the objections to this model are examined.³²

III.2. Criticisms of Shapiro's Model

The critics formulated by Sidak (2007) and Denicolò *et al.* (2007) are of many orders. First, they challenge a recommendation that unfairly favours the defendant to the detriment of the plaintiff. Second, they also challenge the overly negative vision of a plaintiff that is not the patent's owner. They present counter-examples of patent trolls in the biotechnology sector that had an important role in technology exchanges. Third, they show that the conclusions of the Shapiro model rest on assumptions that are not necessarily satisfied in the real world. Among the challenged assumptions are the following: i) infringement is always detected; ii) the value-added of the patented component is supposed to be small relative to the value-added of the product and perfectly observable by a court; iv) the final demand facing the downstream producer does not depend on the amount of the per-unit royalty demanded by the patent holder. The more likely assumption that information is imperfect should lead to an *ex post* level of royalty lower than the one predicted by Shapiro. Moreover, Sidak (2007) argues that since the user of the patented input benefits from the fact that the inventor had to experiment a lot before coming up with the patented innovation, he must incur costs that go well above the value-added of the patented input. It is as if the user benefited from a *real option value* by having delayed the production of its good until the inventor of the input perfected his invention. For all these reasons, the notion of excessive royalties loses some of its relevance.

Denicolò *et al.* (2007) propose an alternative framework. The assumption is made that the value-added by the patented input is *private information* for the defendant, and therefore is not observable by third parties, notably by a court. Thus, the amount of the *reasonable royalty* which serves as benchmark is itself indeterminate. It is therefore impossible for a court to evaluate the part of the royalty demanded by the plaintiff that is due solely to the injunction. The solution to this problem of asymmetric information suggested by the authors is that the court proposes an arbitrary royalty, and that the defendant uses it as an *option value*. If the level of the royalty proposed by the court is superior to the value of the input estimated by the defendant, the defendant has the possibility to request a renegotiation of the royalty with the plaintiff. But, if the royalty proposed by the court is inferior to the input's value, as estimated by the plaintiff, the plaintiff will have to be satisfied with this level.³³

To summarize, the question of knowing whether the plaintiff should be allowed or not to use a preliminary injunction does not have a trivial answer. In any case, the answer to this question should be based on a rule of reason rather than on a *per se* prohibition of the injunction. In the Apple vs Motorola case, the argument of Judge Posner for refusing to ban Motorola's products from the shelves, as Apple sought, was that "*an injunction that imposes greater costs on the defendant than it confers benefits on the plaintiff reduces net social welfare*". Moreover, the case where the injunction is obtained on behalf of a patent pending must be treated with greater caution. The role of patents pending examined below is sufficiently ambiguous to justify a special treatment.

III.3. Role of Divisional and Continuation Patents

³² Elhauge (2008) challenges one of the conclusions of the models by Lemley and Shapiro (2007) and Shapiro (2006), which states that royalties obtained by "surprise" are too high.

³³ The authors do not explicitly list the reasons that incite the plaintiff to accept a renegotiation if the royalty proposed by the court is superior to the value estimated by the defendant, nor the reasons that incite the plaintiff to accept the royalty proposed by the court if it is inferior to the value estimated by the defendant.

According to the OECD (2009), the number of *patents pending* is probably superior to the volume of patents granted that are still in force. Even if a patent is enforceable only if granted, patents pending still have a value. Indeed, they offer to the depositor a temporary protection until the office has made a decision. In particular, complaints for patent infringement can be ruled in favour of the plaintiff even if the infringing behaviour took place during the time the patent still pending. For this reason, patents pending can be instruments as powerful, if not more, as granted patents. Furthermore, patents pending have a greater degree of uncertainty than existing patents, since it is unknown if they will be granted, and if so on which date it will happen and whether they will correspond to strong or weak patents, since the nature and the scope of their claims are not known. Since many *divisional* and *continuation* patent applications originate from the initial depositors, they tend to reduce the transparency on the contents of what is protected, and delay the date on which these protected claims are made public. These applications can give rise to *abuses*. For example, an initial depositor can claim ownership of inventions of which he is not the author, by giving as an argument the existence of a patent pending, the date of which is the initial patent date.³⁴ The rule of the *first to file* that applies presently in all countries amplifies this risk. Some observers anticipate that the recent “*America Invents Act*” law which shifted from a *first to invent* to a *first to file* principle “*will touch off a paper chase to the patent office instead of a race to innovate*” (The New York Times, August 26, 2012).

Even if it may be legal from the point of view of intellectual property law, hold-up behaviour based on pending applications constitute a large obstacle to competition, notably on technological markets, since it prevents some producers from pursuing the commercial exploitation of their activities. This situation is the reason why a report from the Federal Trade Commission in 2011³⁵ put a particular emphasis on the requirement to clarify the notification procedures (procedures that consist in revealing the contents of what is patented and the scope of protection), both for granted patents and patents pending. The precision of the notification affects the competition at each step of the innovation process. The capacity of an operator to identify existing patents or pending applications allows him to negotiate *ex ante* a license, and thus to shield himself from the risk of apparition of *blocking patents* (Green and Scotchmer, 1995). In the absence of precise information, the possibility of being victim of a threat of injunction can cause socially useful investment in R&D to never be undertaken, or lead to high levels of royalties be paid *ex post* to the patent holder. Moreover, an incomplete notification procedure does not allow potential users to negotiate *ex ante* the amount of royalties to be paid. To sum-up, pending patent applications seriously affect competition conditions on the market for technological exchanges.

IV. Patent Pools, Standards and Competition in Innovation Markets

A third conception of the role of patents is based on activities that require the simultaneous use of many inputs, each being protected by an independent patent. This situation corresponds to a configuration of cumulative innovation that Scotchmer (2004) designates under the metaphor of *Research Tools*. This configuration is somewhat different from the sequential innovation examined in the preceding paragraph. The central point is now the *piling of scattered patents* (Denicolò and Halmenschlager, 2012). This situation is common to many activities, such as the pharmaceutical industry, in which patents on genetic codes are essential for the development of new therapeutic targets, or such as the software industry in which a number of computer programs, which have their code protected, play a considerable role in the development of new software. The great number of patents involved impedes the prior negotiation between one user and every patent holder, giving

³⁴ “*Filing of divisional applications enables some brand name pharmaceuticals to maintain the uncertainty generated by their parent patent application and to sue the producers of generic drugs that try to enter the market, in the ignorance of pending patent applications and their respective content*” (European Commission, Pharmaceutical Sector Inquiry Preliminary Report, 28 November 2008).

³⁵ FTC, “The Evolving IP Marketplace: Aligning Patent Notice and Remedies with Competition”, 2011.

rise to the *tragedy of the anti-commons*, a concept penned by Heller (1998) and Heller and Eisenberg (1998), and tested empirically by Murray and Stern (2007) and Cockburn *et al.* (2010). According to this phenomenon, fragmented property rights on a common resource lead to a sub-utilization of that resource. Furthermore, Hall and Ziedonis (2001) and Ziedonis (2004) showed that if patents on complementary innovations were highly dispersed among owners, firms requiring these patents would in turn intensively patent their own innovations to obtain a higher bargaining power with regards to the patent holders. This observation illustrates the role of *patent portfolios* as negotiation instruments (*bargaining chips* in the language of Hall and Ziedonis). In what follows, we examine: i/ the question of the competition bias that results from the multiplication of patents (*patent thicket*) required to produce a good (IV.1); ii/ the problems highlighted by the grouping of these patents in a *patent pool* (IV.2); iii/ and finally the questions posed by *technological standards*, *essential patents* and their *licensing rules* (IV.3).

IV.1 Competition Bias due to the Patent Thicket Problem

A patent thicket is a situation in which a technology is covered by many patents owned by different parties. It is defined by Shapiro (2001) in the following way: "a dense web of overlapping intellectual property rights that a company must hack its way through in order to actually commercialize new technology." The multiplication of patent thickets in varied sectors such as semi-conductors, biotechnologies, nanotechnologies and informatics software (Ayres and Parchomovsky, 2007; IPO, 2011) poses a number of problems.³⁶ In particular, because of patent thickets, potential users of a technology must pay royalties to multiple patent owners, each of them benefiting to a certain extent from *veto power* on the new innovation. Patent thickets considerably increase the costs of negotiation between the patent owners and the user, who must obtain many licences before being able to innovate. From the viewpoint of microeconomic theory, each patent owner can be seen as a monopoly that controls an input necessary for the production of the new innovation.³⁷ The existence of the patent thicket could then lead to a weakening of the incentives to innovate, if the sum of the individual royalties is sufficiently high to make the planned innovation not profitable. The multiplicity of essential patents can thus block ulterior innovations. This issue is important, especially when these patents are part of the elaboration of technological standards, and when users have incurred sunk costs to achieve conformity with that standard. How can we eliminate the inefficiency associated with essential patents and with the *double margin* phenomenon? The economic literature proposes various solutions. A first solution consists of the establishment of a system of *cross licensing* with or without reciprocal royalties. As underlined by Shapiro (2001, p. 123), "*If two patent holders are the only companies realistically capable of manufacturing products that utilize their intellectual property rights, a royalty-free cross licence is ideal from the view point of ex post competition. But any cross license is superior to a world in which the patent holders fail to cooperate, since neither could proceed with actual production and sale in that world without infringing on the other's patents.*" A second solution, examined in the following paragraph, is the creation of *patent pools*.

IV.2. Patent Pools

³⁶ The reader will find in Lemley and Shapiro (2005) an in-depth analysis of the reasons explaining the multiplication of patent thickets. Also, IPO (2011) provides an analysis of the different real-life situations that are covered by this definition.

³⁷ This problem, analogous to that of the double margin, is well known in industrial economics. An enterprise who must buy various inputs, each from separate monopolies, will pay a global price that is higher than the price that would be paid if all the inputs were sold by a single monopoly. As highlighted by Shapiro (2001), "*this is merely a magnified version of the monopoly burden resulting from the patent itself, but it is well to remember Cournot's lesson that the multiple burdens reduce both consumer welfare and the profits of patentees in comparison with a coordinated licensing approach.*"

Patent pools are widely used to cover technologies that are part of technological standards. We will first present arguments in favour and against patent pools (IV.2.1), before examining specific issues related to essential patents in technological standards (IV.2.2).

IV.2.1. Arguments in favour and against patent pools

A patent pool can be defined as an "*agreement among patent owners to license a set of their patents to one another or third parties*" (Lerner and Tirole, 2004). Put differently, patent pools "*aim at granting a single license for a package of patents belonging to different owners*" (Lévêque and Menière, 2007). Organizing joint licensing of all the patents which read for instance on a technological standard is a way to save transaction costs that are inherent to separate licensing.³⁸ Examples of patent pools include MPEG-2 (1997), MPEG-4 (1998), Bluetooth (1998), DVD-ROM (1998), DVD-Video (1999), 3G Mobile Communications (2001) and One-Blue (2009). Patent pool members have long been suspected of facilitating the implementation of anti-competitive behaviour. However, this view has been challenged recently as competition authorities now recognize that they may contribute to "*integrating complementary technologies, reducing transaction costs, clearing blocking positions, decreasing infringement litigation*³⁹ and the uncertainties related to it, and promoting the dissemination of technologies" (US Department of Justice and the Federal Trade Commission, 2007, pp. 84-85).⁴⁰ The doctrine now defended by the US Department of Justice about patent pools is the following: (i) a pool can contain only essential patents, namely patents that are necessary to implement a given technology;⁴¹ (ii) a pool should include a provision allowing for independent licensing (i.e. the requirement that independent licences be offered by pool members to third parties); and (iii) the royalty rates and the grant-back provisions must be subject to particular monitoring.⁴² The European Commission shares the positions of the US Department of Justice, but goes further in its guidelines on the structure and organisation of a patent pool.⁴³

Two types of questions are important in the analysis of the effects of patent pools on competition in the technological exchange market and the innovation market. The first is the degree of substitutability and/or complementarity of patents in the pool, and the second is whether patent pools should authorise patent holders to grant individual licences independently from the joint offer of the pool.

³⁸ "The patent pool dedicated to the MPEG-2 video compression standard is a good illustration of the efficiencies achieved by joint licensing. Owners of patents reading on MPEG-2 delegate to a jointly owned enterprise, MPEG LA, the task of licensing their patents as a single package. The pool was created in 1997 by 8 organizations holding some 100 patents representing 60 % of the patents reading on the MPEG-2 standard. The pool has since expanded rapidly. In 2004 it was comprised of 650 patents owned by 25 organizations, accounting for more than 90 % of the patents surrounding the standard. The MPEG-2 patent pool offers "one-stop shopping" to users of the standard. It thereby saves search and negotiation costs for would-be licenses." (Lévêque and Menière, 2007)

³⁹ Delcamp (2010), using data on 1564 essential US patents belonging to 8 different pools and a control database with patents having the same characteristics, shows that patents included in a pool are more litigated than non-pool patents presenting the same characteristics (patent holder being the plaintiff in the litigation).

⁴⁰ We do not examine in this article the questions of formation and stability of patent pools. See Aoki and Nagaoka (2004), Brenner (2009) and Lévêque and Menière (2011). Similarly, we do not discuss the empirical literature on patent pools. See Lerner, Stojwas and Tirole (2007), Lampe and Moser (2010, 2011), Layne-Farrar and Lerner (2011), Baron and Delcamp (2010), Baron and Pohlman (2011), Delcamp (2011).

⁴¹ By contrast, as underlined by Lerner and Tirole (2008), before 1995, there were almost no provisions relative to the inclusion of essential patents in the pools.

⁴² Lerner and Tirole (2008, p. 167) underline that, "*grant-back provisions force members of the pool to turn to the pool for free at a low price future patents that will be deemed essential to the working of the pool.*" The reader will find in that article a discussion on the introduction of grant-back provisions in the functioning rules of a pool both from the point of view of pool members and society at large.

⁴³ For more details, see, for example, Lerner and Tirole (2008, p. 161).

(i) Complementary vs. Substitute Patents

To find out if patent pools have pro- or anti-competitive effects, we must first know if patent pools should include only complementary patents, or if substitutable patents should be allowed as well.⁴⁴ A well-known result is that patent pools increase welfare when included patents are perfect complements, but reduce welfare when they are perfect substitutes (Shapiro, 2001; Gilbert, 2004; Lerner and Tirole, 2004; Lerner *et al.*, 2007). The argument is simple: a patent pool formed by patents that are perfect substitutes (i.e. distinct patents that fulfil the same functionality) is analogous to a cartel on the product market, because its goal is to eliminate competition on royalties between patent holders.⁴⁵ In the absence of the patent pool, the situation would be analogous to Bertrand competition with license prices tending to marginal cost. The argument according to which a pool of substitutable patents can reduce transaction costs is also invalid, because users need a license only when patents are substitutable.⁴⁶ Conversely, when patents are perfect complements, royalties are reduced because the pool participants internalize the effect of their pricing on the demand for complementary patents. As a result, a patent pool increases both profit and user welfare: *"a pool eliminates royalty stacking and benefits both patent holders and technology users"* (Lerner and Tirole, 2008, p. 162). Two cases should nevertheless be distinguished: a licensor vertically integrated in the industry in which the license is used (insider), and a licensor not active in that industry (outsider).⁴⁷

Furthermore, it can be difficult for competition authorities to evaluate whether patents are complements or substitutes, because patents included in a pool are generally not pure complements or pure substitutes. This distinction makes sense only in a dynamic perspective: patents covering a given technology are complements when the price for licences is low and substitutes when the price is high. Moreover, two patents can be complements for a given functionality at a point in time, but be substitutes for a different functionality at another time. Lerner and Tirole (2004) analyse the positive and negative effects on welfare of pools composed of patents that are not perfect complements or substitutes. The four main results are:⁴⁸ (i) pools with patents that are close complements have a higher probability of increasing welfare; (ii) including in a pool a patent that has

⁴⁴ The traditional definition of substitutability (respectively, complementarity) is that two goods are substitutes (complements) if increasing the price of one good raises (lowers) the demand for the other.

⁴⁵ In March 1998 the FTC challenged a pool created by Summit Technology, Inc and Visx, Inc, on the ground that it was anticompetitive. The pool contained patents related to two different types of laser used for eye surgery, and removed price competition between the two products. As the FTC stated: *"Instead of competing with each other, the firms placed their competing patents in a patent pool and share the proceeds each and every time a Summit or VISX laser is used"* (Lévêque and Menière, 2007).

⁴⁶ However, Kato (2004) shows that, under certain conditions, patent pools composed of substitutable patents may also enhance consumer welfare.

⁴⁷ Kim (2004) shows that vertical integration always lowers the price of the final good if there is a pool and all patents are complements. In other words, the economic efficiency argument for patent pools is enhanced when some firms are vertically integrated. Lévêque and Menière (2007) also emphasizes this point: *"The entry of pure patent holders has complicated the setting of cumulative royalties within patent pools ... Pure patent owners derive their revenue solely from licensing. Hence their interest is to leverage the market power of the pool in order to set a high royalty. The interests of integrated manufacturers are different because of their presence on downstream product market [...] On the one hand they are licensors who derive more revenue from a high royalty. On the other hand, they are licensees who must pay royalties (e.g., the share of the package royalty that is distributed to the other patent owners) for their manufacturing activity. Because of this second effect, integrated patent owners are more reluctant than non-integrated patent owners to charge high cumulative royalties for the package of patents."*

⁴⁸ Note that Lerner and Tirole's model (2004) makes several assumptions, some of which are strong. They are: (i) user preferences are separable; (ii) pools cannot be formed with a subset of the relevant patents; (iii) only polar cases of closed pool and pure third-party licensing by the pool are dealt with.

close substitutes outside the pool can reduce collective welfare, unless the patent pool allows its members to grant individual licenses (see the next section); (iii) the incentives for patent holders to invent around or try invalidate patents held by other members are dulled by the formation of a patent pool; (iv) pools reduce the differentiation of downstream users when the latter are also licensors.

(ii) Collective Licences and/or Individual Licences

The pro- and anti-competitive effects of patent pools also depend on the possibility for individual owners to grant individual licenses independently of the patent pool's collective license. In the case of perfect substitutes, independent licenses would allow the re-establishment of a form of competition and to limit the monopoly power of the patent pool. However, why would the patent pool be allowed in the first place? In the case of perfect complements, independent licenses make no sense. The intuition is the following: independent licences can function if users of a technology can be satisfied with the purchase of a small number of individual licences instead of buying the whole set of licences as a bundle from the patent pool. However, in this case, the problem of royalty stacking would reappear: the price paid by the users would be superior to the pool's profit-maximising price. The immediate consequence of this royalty stacking is that the patent pool is not affected by the possibility that its members grant individual licenses (Lerner and Tirole, 2008). We thus understand that the issue of independent licenses makes sense only in cases in which patents are neither perfect complements nor perfect substitutes. The possibility for the licensor to license its intellectual property rights independently of the patent pool introduces a potential competition for the pool's offer, especially if the latter offers a bundle of licenses that contains more licenses than what the users of a given technology need. In this case, the users will prefer buying a smaller bundle at a lower price. Independent licenses can thus discourage the formation of patent pools even when these pools would actually increase social welfare. Inversely, the possibility for patent holders to grant independent licenses does not always constitute a sufficient constraint for pools that eliminate competition.

Lerner and Tirole (2004, 2008a) find the following results: *"Independent licensing perfectly screens out good pools and bad pools : (i) independent licensing is an irrelevant covenant when the pool aims at lowering the overall price of the technology below the price that prevails in the absence of pooling arrangements (royalty stacking); (ii) Independent licensing restores competition and re-establishes the price of the technology at the pre-pool level when the pool aims at raising the price of the technology (suppression of competition)... Overall, while the conclusion that independent licensing always screens in good pools and screens out bad ones must be qualified, the case in favor of pools with independent licensing remains quite strong, even from an ex post perspective, in our current state of knowledge"* (Lerner and Tirole, 2008a, p. 166-67).⁴⁹

IV.2.2 Essential Patents and Technology Standards

Whether technological standards are always beneficial for society or can lead to welfare losses is a two-sided question. On one hand, the social welfare provided by a technological standard is positive when the demand for final products that use the standard is characterized by strong network

⁴⁹ Brenner (2009), using a setup close to Lerner and Tirole (2004), addresses the issue of optimal patent pool formation when pools may be either pro- or anticompetitive, which ultimately depends on the degree of complementarity among patents. He shows that exclusive pool membership (a situation where a firm is allowed to participate in the start-up of a pool only if all other pool initiators agree) must be added to licensing rules for a pool to be welfare enhancing. Assuming that complementary patents may be either essential or nonessential, Quint (2012) finds that a pool containing only nonessential patents can reduce social welfare, even if the pool is stable to compulsory individual licensing.

externalities and when the standard offers compatibility between the different products that satisfy the same technological norm. For example, cellular telephony would be riddled with problems if mobile phones from different makers were not mutually compatible. On the other hand, the creation of a technological standard necessitates strong cooperation between involved agents, both to obtain an agreement that will become the standard and to define conditions of its usage, notably for the license rules of essential patents included in the standard. This cooperation obviously entails a risk of collusion that can be harmful for society. To know which of these two sides finally prevail is a difficult question, and that is the reason why competition authorities, notably the Department of Justice (DoJ) and the Federal Trade Commission (FTC) in the United States, recommend an analysis based on the rule of reason and not on the application of rules *per se*.⁵⁰

We start by illustrating the importance of technological standards *de jure* stimulated by associations of producers and users, known under the label *Standard Setting Organizations* (SSO). Chiao *et al.* (2007) have identified 59 SSOs operating in the information technology and telecommunications sectors. As underlined by Schmalensee (2009), “*as of 2001, the IEEE-SA (Institute of Electrical and Electronics Engineers Standards Association) alone had 866 active standards and 526 projects in hand, with more than 450 technical working groups and committees.*” SSOs that wish to introduce a new standard must achieve a Standard Setting Agreement (SSA). The existence of SSOs can obviously create problems from the viewpoint of competition policy. Some SSOs can fall under Article 101(1) of the Treaty on the Functioning of the European Union (TFUE), in the sense that they may be considered as constituting a horizontal agreement between competitors, which is prohibited *per se* by Article 101(1).⁵¹ An SSO can indeed distort competition in two ways: upstream between patent owners when they allow the selection of a single technology to the detriment of alternative solutions, and downstream between the users of the standard if the terms of the contract lead to licence conditions that are excessive or discriminatory. An SSA can also fall under Article 102 of the TFUE when the amount of royalties required after the standard is adopted is found excessive. Indeed, this situation can be considered as an abuse of a dominant position.⁵²

⁵⁰ See US DoJ and FTC, Antitrust Enforcement and Intellectual Property Rights, Promoting Innovation and Competition, 2007, Ch. 2.

⁵¹ The European Commission Guidelines on the applicability of Article 101 TFEU to horizontal co-operation agreements recognizes the potential beneficial impact of standard setting agreements on technological progress but warns about the potential for restrictions, too: “*Standardization agreements usually produce significant positive economic effects, for example by promoting economic interpenetration on the internal market and encouraging the development of new and improved products or markets and improved supply conditions. Standards thus normally increase competition and lower output and sales costs, benefiting economies as a whole. Standards may maintain and enhance quality, provide information and ensure interoperability and compatibility thus increasing value of the consumer* (263). *Standard-setting can, however, in specific circumstances, also give rise to restrictive effects on competition by potentially restricting price competition and limiting or controlling production, markets, innovation or technical development. This can occur through three channels, namely reduction in price competition, foreclosure of innovative technologies and exclusion of, or discrimination against, certain companies by prevention of effective access to the standard* (264)”. Note that “*a SSA may be exempted from article 101(1) TFEU by article 101(3), which exempts horizontal agreements contributing to technological progress ... In order to assess whether a standard setting agreement may be exempted from Article 101(1), one needs to establish whether an actual standard setting agreement (a) contributes to technological or economic progress, (b) while allowing consumers a fair share of the resulting benefit, (c) without imposing restrictions which are not indispensable for the attainment of the efficiencies, (d) without eliminating competition in respect of a substantial part of the products in question*” (Stryszowska 2010).

⁵² The *Rambus* and *Qualcomm* cases illustrate the difficulties in proving a violation of Article 102 of the TFUE. The interested reader will find in Lévêque and Menière (2009) references for the numerous commentaries on these two cases.

Another issue highlighted by Farrell et al. (2007, p. 607) is that *“ex ante, before an industry standard is chosen, there are various attractive technologies, but ex post, after industry participants choose a standard and take steps to implement it, alternative technologies become less attractive. Thus a patent covering a standard may confer market power ex post that was much weaker ex ante.”*⁵³ The alternative technological solutions can even be forced to leave the market. Once a standard has been adopted, it is indeed almost impossible to replace a technological solution for another, given the costs that users would need to incur. This situation leads to a hold-up problem: *“the risk of hold-up comes from the nature of investments that manufacturers of standard-compliant equipment have to undertake for testing, designating and producing. Usually, these investments are very specific to the chosen standard. As a result, they cannot be easily redeployed to other uses... Because of this lock-in effect, manufacturers are ready to pay a much higher royalty after the standard is adopted than before”* (Lévêque and Menière, 2009).

In fact, most SSOs adopted rules that allow the mitigation of the hold-up risk associated with the creation of a standard: *“these rules cluster in three areas: disclosure rules, requiring certain disclosures of patents or patent applications; negotiation rules, regarding the timing and locus of license negotiations; and licensing rules, governing the level and structure of royalties, most often requiring participants to license essential patents on “Fair, Reasonable and Non-Discriminatory” (FRAND) or “Reasonable and Non-Discriminatory” (RAND) terms”* (Farrell et al., 2007, p. 609).⁵⁴

The delimitation of so-called *essential* patents leads to decisions that are crucial in the ulterior development of the standard. However, despite the pretention that this delimitation is the result of technical expertise, it is still susceptible to two sources of bias. The first bias is due to the contents of the list of patents declared essential. Firms participating in the establishment of the standard are encouraged to identify all the patents that they consider as necessary for the usage of the standard. That list can be considerably longer than the list constituted by external experts. The first bias is thus an *excess of essential patents*.⁵⁵ The second source of bias has an effect opposite to the first. For strategic reasons, an enterprise can choose not to list one or many of its patents at the time of the establishment of the standard, only to use them at a later date to sue users of the standard.⁵⁶ The

⁵³ Interoperability is another problem in this situation. The development of a given standard can stimulate the development of another technology compatible with the new standard but incompatible with the alternative technology that was not chosen by the standard. As highlighted by Stryzowska (2010), *“for example, an introduction of a standard for a given type of microprocessor may yield a risk of the incompatibility between newly developed memory cards and an alternative microprocessor. In that case, an alternative type of microprocessor may have little chances to survive.”*

⁵⁴ Moreover, Farrell et al. (2007, p. 624) specify that *“the disclosure rules seek to eliminate pure hold-up and allow SSO members to judge for themselves whether other protections will adequately limit hold-up in a particular case; negotiation rules could help make negotiations better reflect ex ante competition, but overblown concerns about collective negotiation weaken this approach; and licensing rules are best seen as an impressive but binding default ex ante contract.”*

⁵⁵ To illustrate, Goodman and Myers (2005) examined the patents declared essential for 3G cellular technology and made two conclusions: (i) 75 per cent of patents (nearly 8000) that are declared essential for that standard are owned by four companies; (ii) only 21% of patents that are declared essential are truly essential, according to experts in that field including the authors of that paper.

⁵⁶ This strategy of ambush or hold-up is described by the OECD as follows: *“The implementation of an ambush strategy by means of patents pending consists of a firm not informing the standard organisation that she applied for patents in relation to the norm being established. At the same time, the firm also modifies the claims in these applications so that they correspond to the future standard. The firm can also have an influence on the standard, so that it is closer to the claims in her patent applications. The enterprise can thus modify both the standard and its own claims in pending applications so that they coincide as much as possible. If everything goes according to plan, the standard organisation publishes a norm that is covered by the undisclosed patents pending, while the enterprise carries on with the application procedures, from the examination to the granting of the patent. Meanwhile, other enterprises apply the standard to their own products. Important irrecoverable*

timing of this ambush strategy, which is often based on patents pending, is crucial, as highlighted by an OECD (2009) report: *"If the enterprise had revealed the existence of its patents pending during the standard's elaboration negotiations, the standard organisation could have chosen a different, less costly technology (if possible) or could have tried to convince the firm to limit the amount of her royalties. However, keeping her patents secret until the norm is applied widely enough to prevent the establishment and application of another standard allows the firm to acquire a dominant position that she would have not acquired in other circumstances."*

Following this reasoning to the letter, we could be tempted to conclude that, in the measure that the obtainment of the dominant position is through abusive behaviour, antitrust authorities have the means to stop ambushes in technological standards organisations.⁵⁷ This task is difficult for two reasons.⁵⁸ The first is that antitrust authorities cannot force members of standards organisations to disclose their patents and patents pending that are related to the norm in consideration. The incentives to do so depend essentially on the internal functioning rules of the standards organisations. The second reason is that antitrust authorities cannot force the organisations' members to announce the maximal price of licenses and the restrictive conditions they would impose for the use of their patents. Also, the authorities do not have the power to prescribe the conditions of sale of licenses. These requirements are borne more of an eventual public regulation of the market for licenses than from the application of competition law. In general, standards organisations themselves set the contracting rules in these matters.

A vast literature was developed to define reasonable license prices.⁵⁹ The simplest solution to the hold-up problem is to have royalties fixed before the adoption of the standard. However, this solution is difficult to implement in practice. Indeed, patent holders do not know the whole potential of the technology before the standard is developed, and thus are incapable of estimating the profits that they could enjoy from their licenses. Moreover, even in the case of royalties that are a percentage of the sale price, the price-elasticity of the product on the downstream market can be poorly estimated. A possible solution would be for the patent owners to commit *ex ante* not to demand excessive royalties *ex post* that result from the foreclosure of alternative technologies.

Some SSOs thus tried to resolve the hold-up problem by asking their members to commit to having license conditions in which *ex post* royalties are *fair, reasonable and non-discriminatory* (FRAND), although without specifying the exact amount *ex ante*. A violation of these terms can be subject to legal proceedings.⁶⁰ FRAND terms are obviously subject to interpretation. They can be interpreted as

investments are made on the basis of the norm. When the ambushing enterprise is certain that the sunk costs incurred by other firms are large enough to discourage the transition to another norm, she reveals the existence of her patents and attacks, threatening with actions to be compensated for damages. She can decide to ask for large royalties or to simply block the application of the technology in question" (OECD, 2009, translated from French). This example illustrates once again the strategic role of patents pending. This strategy was used in recent cases, including Rambus and Qualcomm.

⁵⁷ However, note that there is a difference between Europe and the United States. In Europe, abuse of a dominant position is punished by Article 102 of the TFEU. This article is not focused solely on dominant positions acquired through abusive behaviour. Because the acquisition or the attempt to acquire a dominant position by anticompetitive manners is not in the scope of Article 102, antitrust laws of the European Treaty do not allow the resort to corrective measures to combat ambush strategies in standards organisations. On the contrary, in the United States, the acquisition of a monopoly through misleading, as is the case in the standards context, is under the scope of competition law.

⁵⁸ See Anton and Yao (1995), Froeb and Ganglmair (2009)

⁵⁹ See among others: Farrell *et al.* (2007), Lévêque and Menière (2009), and Gilbert (2011).

⁶⁰ Given that the notion of a fair and reasonable price is imprecise, it is not surprising that multiple controversies emerged on the subject. Therefore, the predictability of the royalties is limited both for the licensee and the licensor. In case of litigation, courts will not be able to assess if the amount of the royalty is

the license amount that would have been negotiated *ex ante* if the economic value of the standard was known. This interpretation supposes that the marginal contribution of each patent used in the standard can be estimated. It is obvious that royalties will be low for patents that are non-essential or replaceable and subject to *ex ante* competition, whereas royalties will be higher for patents that are essential and non-replaceable. FRAND terms are interesting precisely for replaceable patents to avoid rent extraction *ex post*, when competition has been eliminated. One proposition that is often made is to cap the amount of royalties asked by a patent holder at the incremental value of the patent to the standard (Dolmans *et al.*, 2007; Farrell *et al.*, 2007). *"This rule considers that a licence should be established according to the ex-ante incremental contribution value of the chosen technology as compared to the next best alternative, measured at the stage in which other substitute technologies were available"* (Layne-Farrar, Llobet and Padilla, 2012). Swanson and Baumol (2005) propose a solution to make this proposition operational: that enterprises wishing to have their technology included in a standard accept to participate in an *ex ante* auction by offering a royalty rate. The technology of the enterprise offering the lowest-royalty will be integrated in the standard. As highlighted by the authors of that proposition, *"the 'best' IP option will be able to command a license fee equal to incremental cost plus the difference in value between the best and the next-best alternatives"* (p. 23).⁶¹ Ganglmair *et al.* (2011) propose an alternative solution in which innovators commit *ex ante* to offer an option-to-license that producers can exercise if they want to include their IP in the final product. This solution is superior to the FRAND licensing system.

In this respect, the work of Layne-Farrar, Llobet and Padilla (2012) is particularly interesting. These authors start by relaxing two assumptions made implicitly in the literature to justify the incremental value rule. They challenge (i) the idea that all R&D is completed at the moment of the adoption of the standard and that the innovations were available to be used in the standard, and (ii) that enterprises holding patents all choose to join an SSO. The authors show that if patent holders have the choice (and not the obligation) to join an SSO, then they generally prefer to stay out of the SSO even if the latter imposes an incremental value rule.⁶² The intuition is the following: the best strategy for patent holders is to stay out of the SSO and hope that the substitutable technology chosen by the default is non-functioning.⁶³ This strategy would allow these outsiders to find themselves in a position of strength *ex post* and to ask for higher royalties. The authors also find that *"in order to ensure the patent holder's participation, SSO members are able to and will be interested in increasing the licensing fees paid to the patent holder above the dictated level by the incremental value."* More precisely, these results depend on the degree of complexity of the standards. In the case of simple

fair and reasonable. Propositions were made to better define these notions, notably by using elements of cooperative game theory. However, these definitions still face technical and legal objections, which make their application controversial. The only approach that could prevent abusive behaviour would be an *ex ante* negotiation between holders of essential patents and a user of the standard, the latter acting as a counterbalance to the seller's bargaining power. However, as mentioned above, the multiplicity of involved patents makes it difficult to hold prior negotiations between a user and all the owners of patents that are necessary to the user. Moreover, because members of the organisation are themselves potential users of the norm, an *ex ante* negotiation for the conditions of sale of the licences could be interpreted as a *concerted practice*, revealing collusion between the members of the organisation. The consequence of these difficulties is that antitrust authorities prefer adopting a flexible interpretation of competition law towards standards organisations by encouraging them to adopt rules that limit the recourse to ambush strategies. When they intervene directly in cases of abuse leading to dominant positions, antitrust authorities use the *rule of reason*, and not prohibition *per se*.

⁶¹ Incremental cost is defined as the cost per unit that patent holders incur as a consequence of licensing their patent.

⁶² Note that this result is not specific to incremental licensing rule and arises for other licensing rules like the benchmark licensing proposed by Lemley and Shapiro (2007).

⁶³ The authors assume *"that the patented technology is superior to the default one but the standard might still be viable if patent holders do not participate, and the SSO needs to rely on the default technology."*

standards formed of a small number of complementary components, R&D efforts of participating enterprises are complementary, thus if an enterprise chooses to join an SSO, its participation will provoke an increase in the R&D of other firms. This chain of events increases the standard's probability of success and thus the probability to see patent holders participate in the standard despite the licensing cap introduced by the incremental value rule. However, this participation is less important in the case of complex standards, because complementarities are dispersed over a greater number of firms. Finally, the authors conclude that *"the overall picture indicates that licensing caps like the incremental value rule tend to reduce the incentives for firms to participate in cooperative standards setting since most standards can be qualified as complex."*

V. Conclusion

In this chapter, we have showed that the contemporary tensions between intellectual property and competition, other than the classical trade-off between static and dynamic efficiency, originate in the evolution of the patent system. Some characteristics of this system indeed lead to distortions in competition that cannot be corrected by a simple application of antitrust laws. Three of these characteristics were examined in details.

1. Many patents of dubious validity are approved by patent offices.

Patents represent the sacrifice that society is willing to make to benefit from the introduction of a new product or production process. This sacrifice is manifested by a temporary exclusion power granted to the patent holder. For this sacrifice to make sense, patentability criteria must be fully satisfied, and the scope of the claims protected by the patent must not be excessive. However, for a variety of reasons examined in this chapter, many patents granted by patent offices do not satisfy these criteria, even when they cover products of great social value. Consequently, competition on the products market is affected: the temporary exclusion power is no longer justified even if holders of dubious patents try to rely on it. It is not the role of competition authorities to verify if practices of patent holders rely on dubious patents or not. However, the increased uncertainty on the quality of existing patents implies that the social costs of patents are increasing. This cost is measured in two ways: either by the legal cost of conflict resolution if the litigation is taken to court, or by the social cost induced by a settlement that can still lead to a welfare loss for consumers. The efficiency of the patent attribution system is a necessary and essential prior for competition law to prevent an abusive usage of the patent, in other words a usage that goes over the legal privileges attached to the title.

2. The usage of patents in sequential innovations enables the hold-up behaviour that affects competition on technological markets.

Beyond the simple intellectual protection against the risk of copying, patents increasingly fulfil an essential role on technological markets as a medium of exchange. Consequently, the protection of an innovation against imitation is often accompanied by a potential blocking power against ulterior innovations that require the use of patented technologies. This blocking power is particularly detrimental, because it is often exercised *ex post*, after the second innovator made the investments necessary to his activity. Technological exchanges can thus be constrained in multiple ways, following a licensing rejection, an excessive usage fee, the usage of a patent pending, or the injunction power that the patent holder can use to stop the activity of the potential infringer. The powers of competition authorities seem limited when dealing with excessive protection, and the usual presumption that a reinforcement of intellectual property always favours innovation is not verified in the case of sequential innovation. Reducing the abusive hold-up behaviour of the holder of a dubious patent is a task that rests upon courts and regulation agencies, and only in part to competition authorities.

3. The simultaneous usage of many patented inputs in complex technologies imposes limits to the competition for innovation.

Another issue beyond the sequential conception to innovation is the effects of fragmented ownership of intellectual property and the quantity of patents necessary for the production of some goods. On one hand, the patent thicket necessary to access the market can be an obstacle for competition. The constitution of patent pools with a collective license can sometimes mitigate this problem, but does not solve other questions such as the nature of, and interactions between the patents constituting the pool, and the degree of autonomy in the granting of licenses. On the other hand, the implementation and functioning of a technological standard necessitates close collaboration mechanisms between the holders of essential patents. This coordination can cause problems in the smooth operation of the innovation market. In particular, the establishment of general principles that must be satisfied by the collective licence's price does not suffice to mitigate the risks of individual deviation and hold-up. Many highly-publicized trials illustrate well the materiality of opportunistic behaviour in the functioning of a standard. However, it is again difficult for competition authorities to prevent these risks or to convict the authors of opportunistic behaviour.

To summarize, the argument defended in this chapter is that we have arrived at a new stage of tensions between intellectual property and competition.

In the previous stage, the goal was to draw borders between intellectual property law and competition law. This task was difficult but feasible. After successive phases, characterized by the alternative dominance of one law over the other,⁶⁴ of which we can observe the traces in the first guidelines established by competition authorities and in the court decisions, a general principle emerged, consisting of the recognition of the specificity of intellectual property before applying antitrust rules. For example, to know whether a restrictive clause in a licence contract violates competition law or not, authorities do not judge the restriction on competition *per se* as if it was applied to a standard market activity. Authorities instead compare the level of competition with the restrictive clauses in the licence to the hypothetical level of competition that would prevail if the license did not exist. If it is estimated that competition would be stronger in the absence of the license, the restrictive clauses are judged as violating competition law. However, if competition would not be stronger without the license, the restrictive clause is not judged as anti-competitive by antitrust authorities. In cases at the border of competition and intellectual property, the application of the reason rule thus progressively replaced *per se* rules.

In the current stage, the origin of the conflict between patents and competition seem to be of a different nature. The conflict resides in the fact that patents are of uncertain quality, and that there are close links between fragmented intellectual property rights. The granting of patents, and the wars that sometimes accompany these decisions, are becoming decisive episodes in the battles between producers operating with complex technologies. To illustrate, we can take a recent example of a transaction involving many patents. Microsoft decided to sell to Facebook more than 800 patents related to advertising, research, on-line commerce, and mobile telephony for over one billion dollars, not long after Microsoft had bought these patents from AOL for 550 million dollars (L'Usine Nouvelle – Reuters, April 24, 2012). How can we analyse this type of transaction? Is it a simple transfer of immaterial assets, translating the existence of comparative advantages according to which Facebook would be better suited than AOL in the exploitation of these patents, while

⁶⁴ At the beginning of the 20th century, patent law seemed to dominate competition law, so that clauses restricting competition in licence contracts were generally allowed. A reversal happened in the 1960s, when competition law started to dominate over patent law. Prohibition criteria were thus applied to some competition-restricting clauses, known in the United States as the "9 no-no's". For a more detailed history of the evolution of the relations between intellectual property law and competition law, see Gilbert (2006).

Microsoft only plays the role of a lucrative middleman? Or is it instead a reinforcement of the economic power of Facebook due to the acquisition of a set of patents that play a considerable role in the negotiations between actors in the digital economy? What is the legal validity of these patents, and how will eventual legal proceedings concerning some of them will be resolved? These questions are complex and illustrate the diversity of the potential conflicts between patents and competition. Another illustration is the recent case before a court in San Jose in California, in which Apple sued Samsung for infringement of several patents used in mobile phones and tablet computers. Because the case was heard before a popular jury that does not necessarily have all the technical knowledge pertaining to the case, the arguments of the plaintiff (Apple) as well as the arguments of the defendant (Samsung) rested on abstract principles. For the plaintiff, the case was not a war between two giants, but simply an opportunity to save the principles and values of intellectual property: Samsung allegedly imitated in three months what Apple developed in three years. For Samsung's lawyer, the principle of competition was violated: *"Today's verdict should not be viewed as a win for Apple, but as a loss for the American consumer. It will lead to fewer choices, less innovation, and potentially higher prices. It is unfortunate that patent law can be manipulated to give one company a monopoly over rectangles with rounded corners, or technology that is being improved every day by Samsung and other companies. Consumers have the right to choices, and they know what they are buying when they purchase Samsung products. This is not the final word in this case or in battles being waged in courts and tribunals around the world, some of which have already rejected many of Apple's claims. Samsung will continue to innovate and offer choices for the consumer."* The Economist analysed the conflict between Apple and Samsung and stated that: *"If, as it seems, Apple has had to resort to the courts to stifle competition and limit consumer choice, then it is a sad day for American innovation. That the company can do so with such impunity is an even sadder reflection of how dysfunctional the patent system in the United States has become"*. This battle of principles is at the heart of contemporary tensions between intellectual property and competition. Furthermore, the verdict of the American court that Samsung infringed on Apple's patents was not the same in a judgement in front of a Japanese court⁶⁵. Should we see this difference in the judgements as a sign that the United States recognizes the applicability of patents to computer software, while other countries have some reservations? As a last word, the evolution of technology invites us to revisit the foundations of the patent system to analyse the new relations between competition and intellectual property, which we have tried to sketch in this chapter.

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